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SYSTEM FOR VARYING THE FLOW RESISTANCE IN ARRANGEMENTS THROUGH WHICH LIQUIDS OR GASES FLOW

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Abstract

The system for varying the flow resistance of arrangements through which liquids or gases flow is preferably utilized as a rapid-action valve in micromechanical apparatuses, particularly in the implantation of insulin pumps into the human organism. The invention aims to disclose simple valves that are suitable for metering minimal quantities and can be manufactured together with the chips in one production step. According to the invention, the system consists of

two symmetrically arranged body halves that are partially metal-coated, parallel to the axis, wherein the valve flaps are etched out of these body halves in accordance with techniques known from the microelectronics industry. The valve body halves consist of semiconductor material and are integrally connected to one another after their manufacture. The system functions by utilizing the force of the electric field on a semiconductor material in the form of an electrically charged body. The valve flaps are pressed into and pulled out of the medium flow by applying an external electric voltage.

Claims

1. A system for varying the flow resistance of arrangements through which liquids or gases flow, wherein said system operates in accordance with the principle of electrostatic deflections and can be manufactured in accordance with techniques known from the microelectronics industry, characterized by the fact that the system according to the invention consists of two symmetrically arranged body halves that are partially metal-coated, parallel to the axis, wherein the valve flaps (3, 4) are etched out of said body halves and the thusly created metal-coated valve body halves (1, 2) are then integrally connected to one another.

2. The system according to Claim 1, characterized by the fact that the metal-coated valve body halves (1, 2) consist of a semiconductor material.

3. The system according to Claims 1 and 2, characterized by the fact that the valve flaps (3, 4) are moved by applying an external electric voltage.

4. The system according to Claims 1-3, characterized by the fact that the metal-coated valve body halves (1, 2) are produced in the form of an integral component during the chip manufacture.

5. The system according to Claims 1-4, characterized by the fact that the integral connection between the metal-coated valve body halves (1, 2) is realized by means of an adhesive or by electrostatically bonding.

See 2 pages of figures

Scope of the invention

The invention pertains to a system for varying the flow resistance of arrangements through which liquids or gases flow.

The system makes it possible to regulate minute quantities of active or hazardous liquids or gases in medicinal or laboratory applications, as well as in the fields of microelectronics and minimal quantity lubrication. The system can be utilized as a rapid-action valve in micromechanical apparatuses, in which the volumetric flow of liquid or gaseous mediums needs to be regulated. One special application of the invention in the field of medicine is the

implantation of insulin pumps into the human organism, as well as the flow control in infusion and transfusion apparatuses.

Characteristics of the state of the art

Numerous devices for regulating a medium flow are known from the state of the art. Most devices operate in a purely mechanical or electromechanical fashion. DD 108 141 discloses a hose clamp valve, in which the medium flow is regulated by reducing the hose cross section with the aid of clamps. In this case, the hose is subjected to relatively high mechanical stresses such that the hose may become permanently deformed. In addition, this device does not allow an exact metering of the medium.

DD148 375 describes a tube valve consisting of a sleeve with a circular cutout that is sealed by means of an elastic membrane. Overflow channels lead to the circular cutout in this valve.

The pressure exerted upon the elastic membrane causes the overflow channels to be opened or closed accordingly. DE 34 45 740 describes a free-flow valve that is based on a purely mechanical principle. In this case, an elastic hose is guided between two counter-coupled bolts. The medium flow is regulated by displacing the bolts toward one another such that the hose is pinched off.

Clamps and other mechanical elements for regulating flow speeds are not suitable for accurate metering of minimal quantities because the flow speed inevitably changes over time. This could have catastrophic consequences if elements of this type are used in medical practice. In addition, a permanent plastic deformation of the hose cross section occurs after devices of this type are used for extended periods of time.

Other known systems for metering minimal quantities are characterized in that they consist of either one-way valves, solenoid valves (DE-OS 29 21 832) or valves that operate based on the piezoelectric effect (EP 0 109 235). The disadvantages of these systems are that they consist of several individual parts and that they cannot be manufactured together with the chip in a single production step. Consequently, the manufacture of these systems is very costly. WO 0025280 describes a solution that operates in accordance with the principle of an electrostatic force on capacitor plates. However, this solution is also unsuitable for eliminating the above-described disadvantages.

Objective of the invention

The invention is based on the objective of developing a system for varying the flow resistance in arrangements through which liquids or gases flow, wherein said system consists of

few individual parts and can be inexpensively manufactured in large quantities. The system should also have a high metering accuracy and operate very reliably.

Description of the invention

The invention pertains to a system for varying the flow resistance in arrangements through which liquids and gases flow, wherein the objective of the invention consists of developing a system of this type that is extremely small, allows the metering of minimal quantities, is not subject to any mechanical fatigue and can be manufactured with chip manufacturing techniques.

According to the invention, this objective is attained with a system that consists of two symmetrically arranged body halves that are partially metal-coated, parallel to the axis, wherein the valve flaps are etched out of said body halves in accordance with techniques known from the microelectronics industry.

The base material for these body halves is a semiconductor material--preferably silicon.

Both sides of this semiconductor material are provided with an insulation layer, e.g., of silicon dioxide, upon which a metal layer is vapor-deposited.

After the etching process, the thusly created valve body halves are symmetrically assembled and integrally connected in accordance with suitable techniques. This connection is preferably produced by means of an adhesive or by electrostatically bonding. The solution according to the invention utilizes the force of the electric field on capacitor plates in the form of metallic vapor-deposited silicon. In this case, the electrostatic deflection principle is applied.

The valve flaps are either attracted or repelled by the valve body halves when an external electric voltage is applied to the valve flaps and the valve body halves.

For example, if the medium flows through the system according to the invention from A to B, the medium flow automatically presses apart the valve flaps.

In order to close the system according to the invention, an external electric voltage of different polarity is applied to the valve flaps and the valve body halves. In this case, the metal-coated sections on the valve flaps and the corresponding valve body halves respectively have the same potential.

Strip conductors leading to the metal-coated sections on the valve body halves serve for supplying the voltage.

In order to open the system according to the invention, an external electric voltage of the same magnitude is applied to the valve flaps. However, this external electric voltage has a different polarity. If the medium flows through the arrangement in the opposite direction, i.e., from B to A, it tends to press the valve flaps together. This is prevented by applying an external

electric voltage of the same magnitude, but different polarity, such that the valve flaps repel one another. The system is closed as described above.

In contrast to conventional flap valves, the advantages of the system according to the invention can be seen in that it can be rapidly closed and is able to operate in both directions. Due to its simple design, the system consists of only two individual parts that can be manufactured quite inexpensively in the form of mass-produced articles.

Due to its small dimensions, the system according to the invention is primarily suitable for metering minimal quantities. It is also advantageous that the system can be easily controlled with low electric voltages. It is particularly advantageous to manufacture the system together with a micromechanical pump and to accommodate the pump and the system according to the invention on one chip.

Since a monocrystalline semiconductor material is used for the valve body halves, the system according to the invention is not subject to any fatigue and, consequently, operates in a highly reliable fashion. Another advantage achieved due to the utilization of this material is the high resistance to aggressive mediums.

Embodiment

One embodiment of the system according to the invention is described in greater detail below. The figures show:

Figure 1, a half section through the system according to the invention;

Figure 2, a side view of the system according to the invention, and

Figure 3, an example of a pump and a system according to the invention arranged on a chip.

The solution according to the invention is suitable for use in the field of medical engineering, for example, in the implantation of insulin pumps into the human organism.

It is particularly advantageous to accommodate the system according to the invention on a chip together with a micromechanical pump. The pump used preferably consists of a diaphragm pump.

In instances in which the metering capacity of a single system does not suffice for the medium throughput, it is possible to utilize the solution according to the invention in the form of a group arrangement. This makes it possible to easily increase the metering capacity.

One possible application is illustrated in Figure 3. The valve/pump system can be easily manufactured from two identical wafers. The manufacture of the two valve body halves 1 and 2, i.e., the two body halves that are partially metal-coated, parallel to the axis and consist of a semiconductor material, preferably silicon, is carried out in accordance with techniques known from the microelectronics industry. When the pump diaphragm 13 is in the aspiration mode, the

medium flows into the pump through the intake channel 9. The intake valves 11 are open and the outlet valves 12 are closed. Once the pump 14 ejects the aspirated medium, the outlet valves 12 are opened and the medium can flow through the outlet channel 10. During this process, a voltage is applied to the intake valves 11 such that these valves are closed. The valves are controlled with the aid of a special electronic control that is dependent on the characteristics of the pump 14. The terminal electrodes of the intake valves 11, the outlet valves 12 and the pump 14 lead to the rear side of the wafer. The two wafers are integrally connected to one another, preferably by means of electrostatic bonding or an adhesive that does not dissolve the medium. In this respect, it is advantageous to arrange special joining aids such as, for example, beads or depressions on the respective wafers.

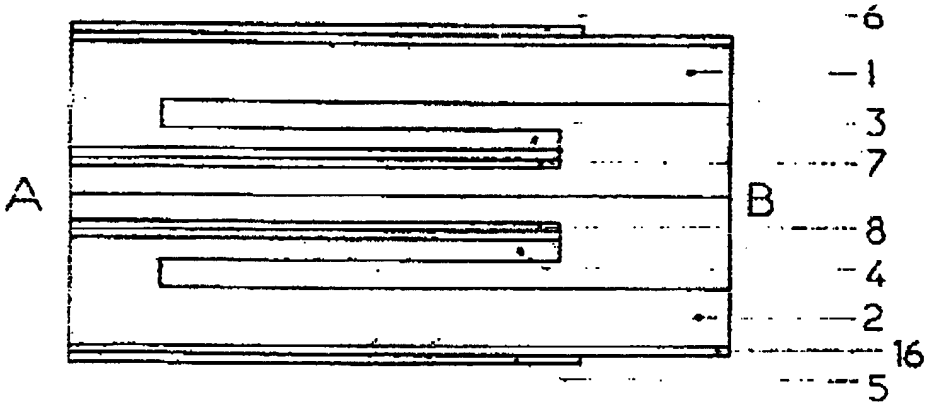

Figure 1

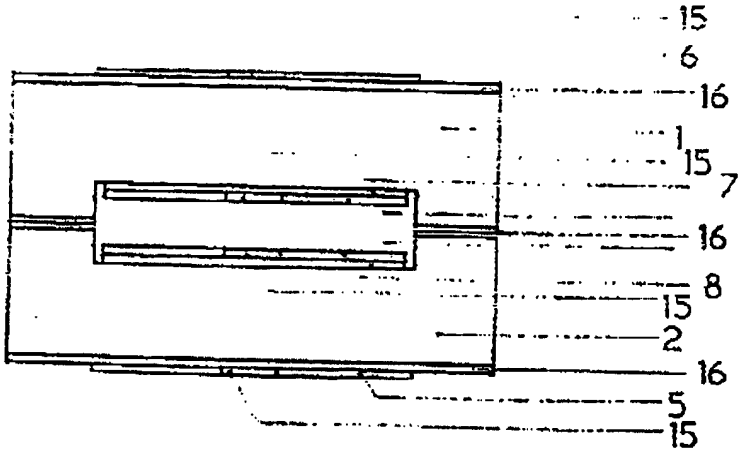

Figure 2

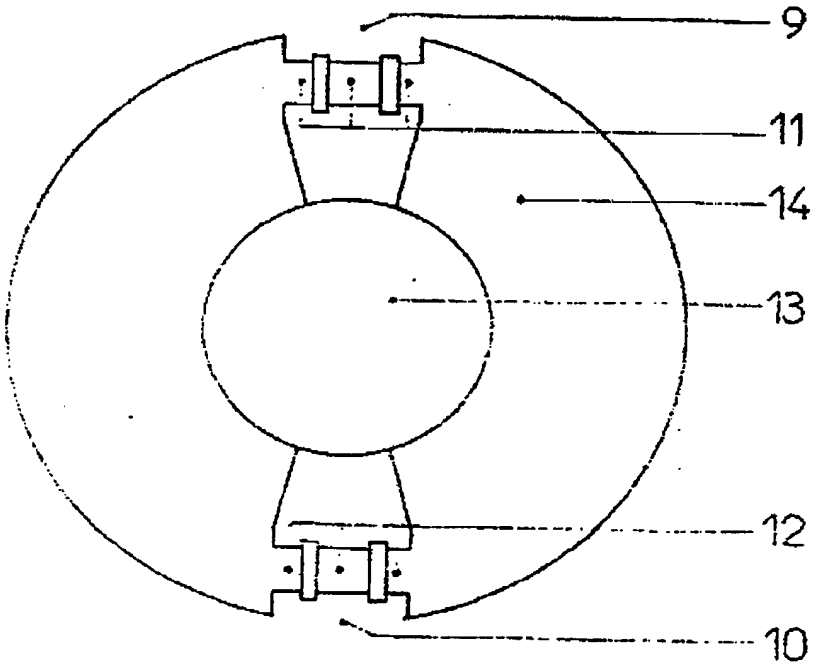

Figure 3